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ABSTRACT

The effect of the interaction between imagery level and number of semantic propositions on junior high readers at three ability levels was studied, using an instrument that compared two levels of imagery at each of five levels of semantic propositions. Syntax, word frequency, and number of arguments were held constant. The results indicated that readers at all levels were more successful in comprehending sentences that had fewer semantic propositions, more words with concrete imagery, or both, and that skilled readers were more likely to be helped by high-imagery words in sentences with many semantic propositions than were unskilled readers. (Author)

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The Effect of Varying Imagery Level and Propositional Complexity on the Comprehension of Sentences

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While the controversy over the dual channel theory of imagery shows signs of abating (Paivio, 1976), the facilitation of comprehension through the availability of both images and language has continued to find consistent support in the literature (Anderson and Hidde, 1971; Holyoak, 1974; Holmes and Langford, 1976; and Katz and Denny, 1977). Because imagery has been demonstrated as an aid to comprehension in relatively simple text forms, the logical next step is to question the facilitative function of imagery in texts of varying levels of complexity.

Kintsch (1974, 1976, 1977) has provided abundant evidence for the increasing difficulty of comprehension of sentences as they increase in number of semantic propositions. Because the semantic proposition is constructed from the relationships between word concepts, it was considered that those propositional relationships that generate concrete images should be easier to comprehend than those relationships that do not lend themselves to higher levels of imagery. Further, it should be reasonable to expect that sentences of the same number of propositions will differ in comprehension difficulty as a function of imagery level.

The investigation of the interaction between imagery and propositional level is of interest as a research question alone; it is of even greater significance to educators in providing the opportunity for generating new and productive hypotheses about the poor reader's reading problems.

Specifically, the purpose of the study was to

investigate the effect of imagery level upon the comprehension of sentences with different numbers of propositions and to evaluate the differences in the effects of the interaction between imagery level and propositions as a function of the reading level of the subject.

METHOD

Subjects

The subjects were seventh and eighth grade students in a predominately white, low-to-middle class community in New York State. Based on the scores of the California Achievement Test, which was administered to the entire junior high population, reading ability was determined and three groups were established: skilled readers, average readers, and unskilled readers. By means of random selection, 100 students from each of the above categories were selected for the sample. The reading scores of the final sample for the unskilled group ranged from 1.8 to 5.0. The average group scores ranged from 5.7 to 8.5, and the skilled were 9.1 to 12.2.

Materials

50 sentences and accompanying test statements which demanded a true-false written response were constructed. The sentences varied on two levels of imagery and five levels of semantic propositions. The first level of semantic propositions consisted of ten sentences containing two

propositions, a range of four to nine words, and two to four arguments. For the second level, 10 sentences were constructed containing four propositions, a range of eight to 13 words, and two to four arguments. The third level consisted of sentences yielding six propositions, a range of 13 to 18 words, and three to five arguments. The sentences for the fourth level consisted of eight propositions, a range of 17 to 22 words, and four to six arguments. The fifth level of sentences was constructed to contain 10 propositions, a range of 28 to 33 words, and six to eight arguments.

Level of imagery was defined as high (concrete) and low (abstract), using Paivio's definitions (Paivio, 1971). Five of the 10 sentences at each of the five propositional levels were constructed with low-imagery words and five were constructed with high-imagery words. Prior to the final selection of items, all sentences were subjected to initial and final ratings for imagery level by peer groups similar to the sample of the major study. In the final imagery rating, on a rating scale of one to three, those sentences with an average mean rating of 1.0 to 1.8 were considered high imagery, and those with a mean rating of 2.2 to 3.0 were considered low-imagery.

Syntactical structure was held constant while imagery varied for each propositional level. Botel, Dawkins, and Granowsky's formula for syntactic complexity was used to compute the syntactic counts for all sentences and test

statements (Botel, Dawkins, & Granowsky, 1973). Word frequency level for sentences and test statements were held constant with computations based upon Kucera and Francis (1967).

To insure that the probability of a correct response to the true-false items would not exceed the acceptable level of 50%, the test statements, without companion sentences, were given to 64 students, similar to those in the major study. The students were required to respond true or false to each test statement without being given any additional information. When chance answers were better than 60%, adjustments were made in the test statement to lower the probability.

The set of sentences and test statements was validated for general form and content by reading specialists, for accuracy of semantic propositions by Kintsch, and for reasoning demands of the sentences and test statements by specialists in logical thought. The final set of sentences and test statements was piloted with a group similar to that of the major study and final modifications were made. A reliability coefficient of .91 was computed on this sample using the Spearman-Brown formula.

Procedures

The test was administered by the student's English teacher, after a study trial of three examples, during a regularly-scheduled English class. Every student was provided with a maximum time allotment of 50 minutes to

complete the task which consisted of reading the 50 sentences, the test statements, and checking the true-false responses.

Data analysis

A total score for the number of correct responses was computed at each of the five levels of propositions in high- and low-imagery items, yielding a total of 10 scores for each subject (N= 300) with a range for each score from zero to five.

In order to determine whether the degree of difficulty in imagery and semantic propositions influences the skilled, the average, and the unskilled reader in the comprehension of a sentence, the data were subjected to three-way analysis of variance with repeated measures on two of the variables (imagery and propositions). This design permitted examination of the main effects of imagery, propositions, and reading ability as well as the interaction of these factors.

RESULTS

Preliminary analyses indicated that there were significant main effects for proposition level, with a decreasing number of correct responses with increase in number of semantic propositions (F= 67.66).

There was a significant main effect for imagery level with more correct responses for sentences of high imagery (F= 217.00).

The analysis of primary interest was the interaction between imagery level and number of propositions. A significant interaction was found (F= 37.77), and a Bonferroni t statistic was used to determine the source of significance between the means for high and low imagery on each of the five propositional levels. More correct responses were given in the high-imagery level than in the low-imagery level on all propositional levels with the exception of level one, the level with the lowest number of propositions, where the reverse was indicated.

The three-way interaction of imagery, propositions, and reading level was also significant (F= 6.06). Bonferroni comparisons were computed and analyses showed that all groups tended to obtain more correct responses when test items were either low in propositional complexity or high in imagery or both. Because low-skilled readers tended to score similarly across all proposition and imagery levels, their responses were less affected by the combination of imagery and proposition levels.

Of further interest is the effect, separately, of imagery level and of proposition level upon the comprehension of the sentences for students at different reading levels. A significant interaction was found between propositional and reading levels (F= 4.50). A Scheffé comparison, used to determine the source of significance between the means of propositional levels for each reading group, showed that comprehension errors tended to increase as number of

semantic propositions increased for the unskilled and average reading groups while for the skilled group, an increase in errors was indicated up to level three, and then showed a reversal at propositional levels four and five. Propositional level affected the unskilled readers more than the skilled readers.

Significant interaction was found between imagery level and reading level ($F = 3.69$), revealing that there were more correct responses at the high imagery level than at the low-imagery level for the three reading groups. While it was expected that imagery level would make more of a difference for the low-ability reader than for the high-ability reader, Bonferroni t tests determined that this did not occur; a larger difference was noted for the average and the skilled reading groups than for the unskilled reader.

DISCUSSION

The results indicate that imagery level affects comprehension differently as a function of the number of propositions; the number of correct responses in high-imagery sentences remained relatively constant across all propositional levels for all readers, while there was a decrease in the number of correct responses in low-imagery sentences across all propositional levels with the exception of level five for all readers. Unfortunately, propositional level five did not function as expected; while a downward trend in number of correct responses occurred in levels one through

four, the number of correct responses increased for level five. This effect was attributed to the fact that the low-imagery mean rating for level five is nearer the midpoint of the one-to-three scale than the low-imagery means of propositional levels three and four. This proximity to the midpoint of the scale and closeness to high imagery might account for a larger mean score of correct responses for low imagery on proposition level five. It is, therefore, reasonable to hypothesize that had the imagery ratings of propositional level five been more like those of three and four, the linear relationship of increasing difficulty of propositional levels would have been consistent.

The propositional level seems to affect the comprehension of low-ability readers more than the high-ability readers as indicated by the decrease in comprehension as propositional levels increased in complexity for unskilled and average readers but not for skilled readers. This finding suggests that the skilled reader has the ability to integrate the relationships that exist in a multipropositional sentence while the unskilled reader has difficulty.

High-imagery level seemed to be used most productively by the high-ability readers rather than the low-ability readers; while the unskilled reader did obtain higher scores for high-imagery items than for low-imagery items, the additional propositional relationships contained in the more difficult propositional levels levels placed a burden upon the reader's ability to comprehend. Imagery level did appear

to facilitate comprehension of complex propositional sentences for the skilled group; while this group was able to process propositions at the most complex levels, their efficiency was increased when these propositions included high imagery.

The findings of the study indicate that both factors, namely, number of propositions and degree of imagery, influence the comprehension performance of the unskilled, the average, and the skilled reader. While increasing the number of propositions in a sentence contributes to comprehension difficulty, high imagery offsets this influence and aids the reader, the skilled reader in particular, in his ability to understand the sentence. The low-ability reader, unable to cope with the higher levels of propositional difficulty, cannot capitalize on high imagery at complex propositional levels.

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Table 1

Means of Five Criteria for 50 Sentences

Proposition and Imagery Levels	Word Frequency Mean	Syntactic Complexity Mean	Imagery Rating Mean	Number of Words Mean	Number of Arguments Mean
Two					
High imagery	82	2.0	1.2	9	3
Low imagery	122	1.4	2.6	6	2
Four					
High imagery	149	3.4	1.4	10	3
Low imagery	172	3.6	2.5	11	4
Six					
High imagery	192	7.0	1.3	16	4
Low imagery	192	6.8	2.4	15	4
Eight					
High imagery	61	9.0	1.6	20	5
Low imagery	247	9.0	2.5	19	5
Ten					
High imagery	152	13.4	1.5	31	7
Low imagery	112	13.6	2.2	30	8

Table 2

Means of Five Criteria for 50 Test Statements

Proposition and Imagery Levels	Word Frequency Mean	Syntactic Complexity Mean	Number of Words Mean	Number of Arguments Mean	Number of Propositions Mean
Two					
High imagery	149	2.6	7.0	2.0	2.6
Low imagery	162	2.2	7.0	2.0	2.8
Four					
High imagery	234	1.8	5.6	2.0	2.0
Low imagery	251	1.8	6.4	2.0	2.0
Six					
High imagery	120	2.6	8.4	3.4	3.2
Low imagery	117	2.4	8.6	2.4	3.2
Eight					
High imagery	40	2.0	6.4	2.4	2.0
Low imagery	110	1.8	7.0	2.2	2.4
Ten					
High imagery	108	4.0	10.2	3.0	4.0
Low imagery	108	2.6	8.0	3.0	3.0

Table 3

Means and Standard Deviations of Correct Responses for Proposition, Imagery, and Reading Levels

Proposition Level	Imagery Level	Reading Level: Unskilled Mean	Unskilled SD	Average Mean	Average SD	Skilled Mean	Skilled SD
One	High	3.17	1.01	3.85	0.81	4.48	0.69
	Low	3.18	1.17	4.08	0.97	4.75	0.58
Two	High	3.28	1.10	3.91	0.93	4.39	0.84
	Low	2.85	1.34	3.48	1.05	4.37	0.76
Three	High	2.80	1.17	3.89	0.96	4.17	0.78
	Low	2.51	1.05	2.81	0.97	3.10	0.82
Four	High	2.95	1.03	3.88	0.88	4.35	0.78
	Low	2.40	1.08	2.68	1.09	3.13	0.99
Five	High	2.95	0.95	3.53	0.99	4.57	0.67
	Low	2.41	1.11	3.22	0.92	3.90	0.89

Table 4

Analysis of Variance of Scores on the Comprehension Test by Imagery, Proposition, and Reading Levels

Source of Variation	Sum of Squares	df	Mean Squares	F Ratio
Between subjects				
Reading level	809.27	2	404.63	232.01
Subjects within groups	517.98	297	1.74	
Within subjects				
Proposition level	227.75	4	56.94	67.66
Proposition level x Reading level	30.29	8	3.79	4.50
Proposition level x subjects within groups	999.74	1188	0.84	
Imagery level	177.63	1	177.63	217.00
Imagery level x Reading level	6.05	2	3.02	3.69
Imagery level x subjects within groups	243.12	297	0.82	
Proposition level x Imagery	124.35	4	31.09	37.77
Reading level x Proposition level x Imagery level	39.91	8	4.99	6.06
Proposition level x Imagery level x subjects within groups	977.92	1188	0.81	

$F_{.01}(1,297) = 6.73$ $F_{.01}(4,1188) = 3.32$

$F_{.05}(1,297) = 3.87$ $F_{.05}(4,1188) = 2.37$

$F_{.01}(2,297) = 4.68$ $F_{.01}(8,1188) = 2.51$

$F_{.05}(2,297) = 3.01$ $F_{.05}(8,1188) = 1.94$

Table 5

Mean Scores of Proposition Levels Across Imagery and Reading Level

One		Two		Three		Four		Five	
Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
3.91	0.87	3.71	1.00	3.21	0.96	3.23	0.98	3.43	0.92

Table 6

Scheffé Cell Mean Comparisons for Proposition Levels Across Imagery and Reading Level

Proposition Level	One	Two	Three	Four	Five
One		0.51	6.24	5.86	2.93
Two			3.18	2.93	1.02
Three				0.01	0.64
Four					0.51

$F_{.01} = 2.17$

Table 7

Mean Scores of Imagery and Proposition Levels Across Reading Level

Imagery Level	Proposition Levels									
	One		Two		Three		Four		Five	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
High	3.83	0.83	3.86	0.96	3.62	0.97	3.73	0.90	3.68	0.87
Low	4.00	0.90	3.57	1.05	2.81	0.95	2.74	1.05	3.18	0.97

Table 8

Mean Scores of Reading Levels Across Proposition and Imagery Level

Unskilled		Average		Skilled	
Mean	SD	Mean	SD	Mean	SD
2.85	1.10	3.53	0.96	4.12	0.78

Table 9

Scheffé Cell Mean Comparisons for Reading Level Across Imagery and Proposition Levels

Reading Level	Average	Skilled
Unskilled	6.63	23.08
Average		4.99

$F_{.01} = 4.66$

Table 10

Bonferroni Cell Mean Comparisons for Imagery and Propositional Levels Across Reading Level

Propositional Levels				
One	Two	Three	Four	Five
2.29	3.91	10.93	13.36	6.75

$\pm_{.01} = 2.58$

Table 11

Mean Scores of Reading and Proposition Levels Across Imagery Level

Proposition Level	Reading Level					
	Unskilled		Average		Skilled	
	Mean	SD	Mean	SD	Mean	SD
One	3.18	1.09	3.97	0.89	4.62	0.63
Two	3.07	1.22	3.70	0.99	4.38	0.80
Three	2.48	1.11	3.35	0.97	3.64	0.80
Four	2.68	1.06	3.28	0.99	3.74	0.89
Five	2.68	1.03	3.38	0.95	4.24	0.78

Table 12

Scheffé Cell Mean Comparisons for Reading and Propositional Levels Across Imagery Level

	Propositional Level			
Groups	One	Two	Three	Four
Unskilled				
Two	0.36			
Three	14.54	10.33		
Four	5.43	4.51	1.19	
Five	5.43	4.51	2.17	0.00
Average				
Two	2.16			
Three	11.41	3.64		
Four	11.41	5.23	0.15	
Five	10.33	3.04	0.03	0.30
Skilled				
Two	1.71			
Three	28.50	16.25		
Four	22.98	12.15	1.09	
Five	4.28	0.58	10.68	7.42

$F_{.01} = 3.32$

$F_{.05} = 2.37$

Table 13

Mean Scores of Reading and Imagery Levels
Across Proposition Level

	Imagery Level			
	High		Low	
Reading Level	Mean	SD	Mean	SD
Unskilled	3.03	1.05	2.67	1.25
Average	3.81	0.91	3.25	1.00
Skilled	4.39	0.75	3.85	0.81

Table 14

Bonferroni Cell Mean Comparisons for Imagery and Reading Levels
Across Proposition Level

Reading Level		
Unskilled	Average	Skilled
6.29	9.79	9.44

$\underline{t}_{.01} = 2.58$

Table 15

Bonferroni Cell Mean Comparisons for High and Low Imagery by Reading and Propositional Levels

Propositional Levels	Reading Level		
	Unskilled	Average	Skilled
	t	t	t
One	0.08	1.79	2.10
Two	3.35	3.35	0.16
Three	2.42	8.42	8.34
Four	4.29	9.35	9.51
Five	4.42	2.42	5.22

$t_{.001} = 3.27$